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Indian Standard
SPECIFICATION FOR EYE-PROTECTORS
(First Revision)

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AMENDMENT NO. 1 OCTOBER 2010
TO
IS 5983 : 1980 SPECIFICATION FOR EYE-PROTECTORS

(First Revision)

[*Page* 7, *clause* 3.1.1(a)] — Substitute 'Safety Goggles' for 'Goggles'.

(*Page* 11, *clause* 5.1.1.3, *line* 4) — Substitute 'cd/(m^2.l*x*) *for* 'cd(m^2.l*x*)'

(*Page* 13, *clause* 5.1.1.7) — Add the following new clause after 5.1.1.7:

'5.1.1.8 At the end of the text, the eye-protectors shall meet the following mechanical and optical requirements:

a) The amount of diffused light shall not exceed the permissible limit given in 5.1.1.3 by more than 25 percent.

b) The robustness of oculars made of synthetic material and laminated glass shall not have fallen below that specified in 5.1.1.6.

c) The ultra-violet, infra-red and visible transmittances shall remain within the limits to which the ocular belongs before the test (*see* 5.2.1.1).'

(*Page* 14, *clause* 5.1.2.4) — Delete.

(CHD 8)

Reprography Unit, BIS, New Delhi, India

Indian Standard
SPECIFICATION FOR EYE-PROTECTORS
(First Revision)

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Indian Standard

SPECIFICATION FOR EYE-PROTECTORS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 30 November 1980, after the draft finalized by the Glassware Sectional Committee had been approved by the Chemical Division Council.

0.2 This standard was first published in 1971 under the title 'Specification for protective filters for welding, cutting and similar operations'. However, need was felt for revising the standard with a view to covering eye-protectors for other operations also thus making it comprehensive. Accordingly, the scope of this standard has now been enlarged to cover eye-protectors for use in operations where small particles flying at high velocity, molten metal, chemical splashes, dust, gases, optical radiations (ultra-violet, infra-red and glare from intense visible light) pose hazards which are likely to impair vision or damage the eye.

0.3 In this revision important aspects, such as designation of filters, classification of eye-protectors and oculars on the basis of their types, constructions and protection provided by them have been covered. General requirements applicable to all eye-protectors and specific requirements applicable to eye-protectors depending on the specific purpose for which they are used, have also been prescribed. Transmission requirements have been prescribed in respect of filters meant for use in flame-welding and braze-welding of heavy metals, welding with emitive fluxes, oxygen cutting, plasma jet thermal cutting, arc welding or arc gouging and direct arc welding in addition to those meant for protection against ultra-violet and infra-red radiations and intense daylight.

0.4 In the formulation of this standard due weightage has been given to international coordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from the following publications:

ISO: 4849 Personal eye-protectors — Specifications.

ISO: 4850 Personal eye-protectors for welding and related techniques — Filters — Utilization and transmittance requirement.

ISO: 4851 Personal eye-protectors — Ultra-violet filters — Utilization and transmittance requirements.

ISO : 4852 Personal eye-protectors — Infra-red filters — Utilization and transmittance requirements.

ISO : 4853 Personal eye-protectors — Daylight filters — Utilization and transmittance requirements for daylight filters, issued by the International Organization for Standardization (ISO).

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies eye-protectors intended for use in industrial undertakings to provide protection for the eyes against hazards such as flying particles and fragments, splashing materials and molten metals harmful dust, gases or vapours, aerosols and radiations which are likely to impair vision or damage the eyes.

NOTE — Where eye-protector is incorporated in protective equipment, such as a hood, helmet or respirator, the portions affording eye protection should comply with relevant requirements of this standard.

1.1.1 This standard, however, does not cover eye-protectors for use against nuclear radiations, X-rays and laser beams.

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given below shall apply.

2.1 Astigmatic Power — The maximum refractive power difference between two meridians along the same sighting axis. It is expressed in 'dioptres'.

2.2 Chemical Goggles — Goggles having a frame of flexible, non-absorbent material which provides protection against harmful chemicals.

2.3 Chromaticity of a Filter — This is defined by the chromaticity coordinates of the light reflected from a truly white screen (that is, magnesium oxide screen), illuminated only by light which passes through the filter in the manner intended in service.

2.4 Colour — The colour of a filter is defined in terms of its chromaticity coordinates using trichromatic system recommended by the International Commission on Illumination (CIE) in 1931. In this system, the colour

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*Rules for rounding off numerical values (*revised*).

is expressed in terms of chromaticity coordinates x, y and z, the sum of which is unity. The coordinate x is analogous to the proportion of red, y to the proportion of green and z to the proportion of blue.

2.5 Cover-all Goggles — An eye-protector designed to fit over vision correcting spectacles.

2.6 Dioptre — The unit of refractive power (1 dioptre $= 1\ \mathrm{m}^{-1}$).

2.7 Double Glazed Lens — Lens consisting of two or more components separated by an air gap and with the normal line of sight passing through all the components.

2.8 Dust-Proof Goggles — Goggles designed to restrict ingress of dust into the orbital areas enclosed by the goggles.

2.9 Eye-Cup Goggles — An eye-protector consisting of two lenses mounted in cups supported by a flexible nose bridge and head band.

2.10 Eye-Protector — Any form of equipment which includes a lens or lenses, worn in front of the eyes to provide protection for the eyes.

2.11 Eye-Shield — A transparent visor supported in front of the face to shield the eyes.

2.12 Face-Shield — A device including a transparent visor, supported in front of the face to shield the eyes, face, forehead and front of neck.

2.13 Filter — An ocular designed to reduce intensity of incident harmful radiations by absorbing and/or reflecting them. It may be plastics, solid glass, laminated construction or other suitable material.

2.14 Filter Cover — A transparent cover used to protect the filter(s) against abrasion and weld spatter. It may be of plastics or any other suitable material.

2.15 Gas-Tight Goggles — Goggles designed to prevent ingress of harmful gases and fumes into the orbital areas enclosed by the goggles.

2.16 Goggles — An eye-protector which fits the contour of the face to enclose the optical area and is held in position by a head band.

2.17 Hood — A device covering the head and neck which includes eye protection.

2.18 Impact Protector — An eye-protector able to provide safety against impact of particles flying at high velocity.

2.19 Luminous Transmittance — The ratio of the transmitted luminous flux to that of the incident luminous flux. In order to calculate this, the spectral luminous efficiency $V(\lambda)$ must be introduced.

$$T_V = \frac{\int_{380\ \text{nm}}^{780\ \text{nm}} \phi_e \lambda\ T(\lambda)\ V(\lambda)\ d\lambda}{\int_{380\ \text{nm}}^{780\ \text{nm}} \phi_e \lambda\ V(\lambda)\ d\lambda}$$

2.20 Meniscus — An ocular having two spherical surfaces of which one is convex and the other concave.

2.21 Molten Metal Protector — An eye-protector able to provide safety against flying molten metals or hot solids.

2.22 Ocular (or Lens) — That part of an eye-protector through which an operator sees.

2.23 Prismatic Power — The apparent angular displacement of an object by an optical system. It is expressed in 'prism dioptres'.

NOTE — A prismatic effect can be produced by prismatic power in the ocular by the position of the ocular relative to its correct visual axis or by a combination of these.

2.24 Refractive Power — The reciprocal of the back focal length of an optical system. It is expressed in 'dioptres'.

2.25 Safety Clip-ons — A pair of protective lenses designed to clip-on over the front of non-safety spectacles.

2.26 Safety Spectacles — An eye-protector the oculars of which are mounted in spectacle type frame, with or without side-shield.

2.27 Shade Number — Defined by the expression:

$$N = 1 + \frac{7}{3} \log 10 . \frac{1}{T_V}$$

where

N = shade number, and

T_V = luminous transmittance (*see* **2.19**).

2.28 Spectral Transmittance — The ratio of the transmitted spectral radiant flux to that of the incident spectral radiant flux.

$$T(\lambda) = \frac{\phi_\lambda}{\phi_{e\lambda}}$$

2.29 Transmittance in Infra-Red Spectrum

a) For welding filters and IR filters, transmittance requirements are given for two wavelength ranges:

Near infra-red — from 780 to 1 300 nm

Mid infra-red — from 1 300 to 2 000 nm

The transmittances are defined by the formulae:

$$T_{\mathrm{NIR}} = \frac{1}{520} \int_{780\ \mathrm{nm}}^{1\,300\ \mathrm{nm}} T\ (\lambda)\ \mathrm{d}\,\lambda$$

$$T_{\mathrm{MIR}} = \frac{1}{700} \int_{1300\ \mathrm{nm}}^{2\,000\ \mathrm{nm}} T\ (\lambda)\ \mathrm{d}\,\lambda$$

b) For daylight filters the solar infra-red transmittance T_{SIR} is obtained by integration, taking as a basis the spectral distribution of solar radiation (*see* Appendix A), between 780 nm and 2 000 nm limits; and using the following formula:

$$T_{\mathrm{SIR}} = \frac{\int_{780\ \mathrm{nm}}^{2\,000\ \mathrm{nm}} E\lambda\ T\ (\lambda)\ \mathrm{d}\,\lambda}{\int_{780\ \mathrm{nm}}^{2\,000\ \mathrm{nm}} E\lambda\ \mathrm{d}\,\lambda}$$

2.30 Welding Goggles — Goggles designed to filter, absorb or reflect harmful radiations emitted during welding, cutting and similar operations.

2.31 Welding Hand-Shield — A rigid eye-protector held in hand for protecting the eyes, face, forehead and front of the neck during welding, cutting and similar operations.

2.32 Welding Helmets — A rigid eye-protector worn by the operator to shield the eyes, face, forehead and front of the neck during welding, cutting or similar operations.

2.33 Wide-Vision Goggles — An eye-protector in which the lens or lenses extend over the full width of the face, affording a large field of vision.

2.34 Wire Mesh Screens — A device consisting of woven metal gauze supported in front of the face and incorporating a transparent lens in front of the eyes.

3. TYPES AND DESIGNATION

3.1 Types

3.1.1 *Eye-Protectors* — Eye-protectors shall be of the following types:

a) Goggles,

b) Safety spectacles,

c) Safety clip-ons

d) Eyes, face and hand shields, and

e) Wire mesh screens.

3.1.2 *Oculars* — Oculars shall be of the following types:

a) *Mineral Oculars* — made of glass. These shall be toughened thermally, chemically or by any other process. (Oculars which have been toughened are also called 'treated' oculars.),

b) *Organic Oculars* — made of plastic material, and

c) *Laminated Oculars* — comprising multiple layers joined together by a binder.

NOTE — Untreated glass may also be used for oculars provided it is backed with either treated glass or plastics cover.

3.1.2.1 All these types of oculars may have coatings on their surface(s) to give additional transmittance characteristics.

3.2 Designation of Filters — Filters shall be designated for their transmittance characteristics by a combination of two numbers, namely, a code number and the shade number of the filter, separated by a hyphen. The designation of welding filters, however, shall not include a code number. For example, a filter meant for protection against ultra-violet radiation having code number 2 and shade number 1·2, shall be designated as 2-1·2 (*see* Table 1).

NOTE — Filters for low temperature infra-red sources are not covered in this standard.

3.2.1 The designations of the various types of filters shall be as specified in Table 1.

4. DESIGN AND MANUFACTURE OF EYE-PROTECTORS

4.0 General — Eye-protectors shall be constructed of appropriate materials, shall be free from visual defects and shall also meet relevant performance requirements.

4.1 Comfort to the Wearer — Eye-protectors shall be free from projections, sharp edges or other features which could cause discomfort. The materials of construction shall be so selected as would avoid skin irritation. In the case of dust-proof goggles, the construction shall allow minimum risk of irritation.

4.2 Head-band — Head-bands, when used, shall be of good quality, durable and at least 10 mm in width.

4.3 Fittings — Adjustable parts or components incorporated in eye-protectors shall be easily adjusted and replaced.

4.4 Ventilation — Except where double-glazed or specially coated filters are used, ventilation shall be provided and adopted to reduce misting.

4.5 Thermal Conductivity — Except for spectacles, all materials which are likely to be exposed to radiation during use and which come in contact with the operator shall have a thermal conductivity of less than 0·2 $W.m^{-1}K^{-1}$.

TABLE 1 DESIGNATIONS OF FILTERS

(*Clauses* 3.2 *and* 3.2.1)

SL NO.	WELDING FILTERS	ULTRA-VIOLET FILTERS		INFRA-RED FILTERS	DAYLIGHT FILTERS	
	Shade Number only	Code Number 2-Shade Number	Code Number 3-Shade Number	Code Number 4-Shade Number	Code Number 5-Shade Number	Code Number 6-Shade Number
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	1·2	2-1·2	3-1·2	4-1·2	5-1·2	6-1·2
ii)	1·4	2-1·4	3-1·4	4-1·4	5-1·4	6-1·4
iii)	1·7	—	3-1·7	4-1·7	5-1·7	6-1·7
iv)	2	—	3-2	4-2	5-2	6-2
v)	—	—	—	4-2*a*†	—	—
vi)	2·5	—	3-2·5	4-2·5	5-2·5	6-2·5
vii)	—	—	—	4-2·5*a*†	—	—
viii)	3	—	3-3	4-3	5-3	6-3
ix)	4	—	3-4	4-4	5-4	6-4
x)	4*a**	—	—	—	—	—
xi)	5	—	3-5	4-5	—	—
xii)	5*a**	—	—	—	—	—
xiii)	6	—	—	4-6	—	—
xiv)	6*a**	—	—	—	—	—
xv)	7	—	—	4-7	—	—
xvi)	7*a**	—	—	—	—	—
xvii)	8	—	—	4-8	—	—
xviii)	9	—	—	4-9	—	—
xix)	10	—	—	4-10	—	—
xx)	11	—	—	—	—	—
xxi)	12	—	—	—	—	—
xxii)	13	—	—	—	—	—
xxiii)	14	—	—	—	—	—
xxiv)	15	—	—	—	—	—
xxv)	16	—	—	—	—	—

*For welding with flux (*see* **B-1.1.2**).

†For protection against infra-red radiation from sources of large area where protection from glare is not essential (*see* Table 17).

4.6 Composition of Oculars — Oculars shall be made of plastics or other suitable synthetic materials, or toughened or laminated glass or any combination of these materials (*see* **3.1.2**), untreated glass may be used only if it is backed with one of the foregoing materials except in the case of oculars used solely against radiations, for example, for welding and against sun-glare, or as cover oculars for the protection of filters.

5. REQUIREMENTS

5.0 General — All eye-protectors shall meet the general requirements given in **5.1**. Furthermore, according to their intended use, eye-protectors shall meet one or more of the specific requirements given in **5.2**.

5.1 General Requirements

5.1.1 *Oculars*

5.1.1.1 *Dimensions* — Oculars shall comply with the following dimensional requirements:

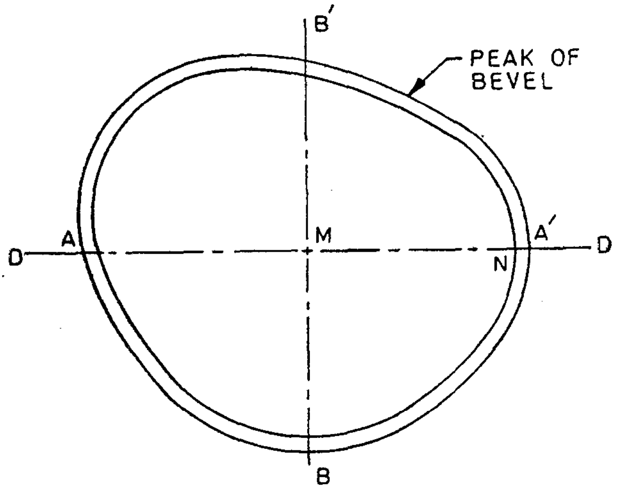
a) *Eye-cup goggles* — Each ocular shall have a datum length (*see* Fig. 1) of not less than 50 mm.

b) *Safety spectacles* — Each ocular shall have a datum length of not less than 42 mm and a mid-datum depth of not less than 32 mm (*see* Fig. 1).

c) *Safety clip-ons* — Each ocular shall have a datum length of not less than 42 mm and a mid-datum depth of not less than 32 mm (*see* Fig. 1).

d) *Eye shields* — The transparent visor of a half-face type of eye shield shall be not less than 100 mm in depth.

e) *Single-frame coverall goggles* — Oculars of coverall goggles fitted in pairs shall have a datum length of not less than 50 mm (*see* Fig. 1).



DD — Datum Line
AA′ — Datum Length of Lens
M — Datum Centre (Mid-Point of AA′)
BB′ — Mid-Datum Depth of Lens (Measured Through M)

FIG. 1 DIMENSIONS OF OCULARS

5.1.1.2 *Optical requirements* — In order to affect vision as little as possible, the prismatic and spherical effects and astigmatism shall be as small as possible.

a) *Unmounted oculars* — Optical requirements of unmounted oculars shall be measured by the method given in **3.1** of IS : 7524 (Part II)-1980*. The permissible tolerances shall be as given in Table 2. All measurements shall be taken for:

- i) *Spherical effect and astigmatism* — at a minimum of four points in an area of 40 mm diameter around the geometrical centre of the ocular. One of the four points shall be the geometrical centre of the ocular and other points may be chosen by agreement between the manufacturer of the oculars and the manufacturer of the eye-protectors using these oculars; and
- ii) *Prismatic effect* — at the geometrical centre of the ocular.

TABLE 2 PERMISSIBLE TOLERANCES FOR SPHERICAL EFFECT, ASTIGMATISM AND PRISMATIC EFFECT FOR UNMOUNTED OCULARS

[*Clause* 5.1.1.2(a)]

TYPE OF OCULARS	SPHERICAL EFFECT, m^{-1}	ASTIGMATISM, m^{-1}	PRISMATIC EFFECT, cm/m
(1)	(2)	(3)	(4)
a)	±0·06	0·06	0·12
b)	±0·12	0·12	0·25

b) *Mounted oculars* — Optical requirements of mounted oculars and spectacles shall be measured in accordance with one of the methods given in **3.2** of IS : 7524 (Part II)-1980*; eye-protectors being positioned on the standard support after being subjected to the test for stability at elevated temperature (*see* **5.1.2.1**). Either of the two methods A or B, by measurement or tolerance, may be used. The permissible tolerances shall be as given in Table 3. All measurements shall be taken as given in (a) and (b) in **5.1.1.2**.

5.1.1.3 *Diffusion of light* — If an ocular diffuses light appreciably, the contrast may be reduced and visual performances adversely affected. Accordingly for the purpose of this standard, the limiting value of light diffusion may be 1·0 cd $(m^2.lx)$ for welding filters and 0·5 cd/$(m^2. lx)$ for all other filters. The scattered light shall be measured in accordance with the method given in **4** of IS : 7524 (Part II)-1980*.

5.1.1.4 *Colour recognition* — Oculars with filtering action, as far as possible shall permit recognition of colours sufficient to the task and the observation

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*Methods of test for eye-protectors: Part II Optical tests (*first revision*).

TABLE 3 PERMISSIBLE TOLERANCES FOR SPHERICAL EFFECT, ASTIGMATISM AND PRISMATIC EFFECT FOR MOUNTED OCULARS

[*Clause* 5.1.1.2(b)]

TYPE OF OCULAR	SPHERICAL EFFECT (POWER IN MERIDIAN OF MAXIMUM ERROR)	ASTIGMATISM	PRISMATIC EFFECT		
			Horizontal		Vertical
			Base out	Base in	
	m^{-1}	m^{-1}	cm/m	cm/m	cm/m
(1)	(2)	(3)	(4)	(5)	(6)
a)	±0·06	0·06	1·00	0·25	0·25
b)	±0·12	0·12	1·00	0·25	0·25
c)	+0·12 −0·25	0·25*	1·00	0·25	0·25

*Axes must be parallel.

of safety signs. Colour tint limits shall be established on the basis of experimental information obtained on filters under actual use conditions and the chromatic adaptation of the human eye.

5.1.1.5 *Quality of material and surface* — Except for a marginal area 5 mm wide, oculars for eye-protectors shall be free from any significant defects likely to impair vision in use, such as bubbles, scratches, inclusions, dull spots, holes, mould marks, scoring or other defects originating from the manufacturing process. The test shall be carried out in accordance with the method given in **5** of IS : 7524 (Part II)-1980*.

5.1.1.6 *Robustness of construction* — Oculars for protection against hazards other than mechanical hazards are exempted from the robustness test. For oculars for protection against radiation, dust and chemicals this test is not required unless the ocular is a combined filter and mechanical safety ocular.

NOTE — When filters for protection against radiation, dust and chemicals are worn in areas of mechanical hazards, an assembly combining such filters with mounted oculars meeting the mechanical hazards specifications should be worn.

a) *Unmounted oculars* — For protection against high-mass low-velocity flying objects the oculars shall be designed to withstand the impact of a 22 mm diameter steel ball, of about 44 g mass, dropped from a height of 1·27 to 1·30 m. The test shall be carried out in accordance with the method given in **4.1** of IS : 7524 (Part I)-1980†. On testing, there shall be no ocular fracture. An ocular shall be considered as having fractured if it cracks

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*Methods of test for eye-protectors: Part II Optical tests (*first revision*).

†Methods of test for eye-protectors: Part I Non-optical tests (*first revision*).

through its entire thickness into two or more pieces; or if more than 5 mg of the ocular material becomes detached from the surface remote from that struck by the ball, or if the ball passes through the ocular.

b) *Mounted oculars* — Mounted oculars shall withstand the impact of a 22 mm diameter steel ball, of about 44 g mass, dropped from a height of 1·27 to 1·30 m. The test shall be carried out in accordance with the method given in **4.2** of IS : 7524 (Part I)-1980*. On so testing, the following defects shall not occur:

- i) *Ocular fracture* — an ocular shall be considered to have fractured if it cracks through its entire thickness into two or more pieces; or if more than 5 mg of the ocular material becomes detached from the surface remote from that struck by the ball;
- ii) *Ocular deformation* — an ocular shall be considered to have deformed if a mark appears on the white paper on the side opposite to that struck by the ball; and
- iii) *Ocular housing or frame failure* — an ocular housing or frame shall be considered to have failed if it separates into several parts, if it is no longer capable of holding an ocular in position; or if an unbroken ocular separates from the frame.

5.1.1.7 *Stability in presence of ultra-violet radiation* — The oculars shall be subjected to the test by exposing them for 100 h to radiation from a quartz-envelop high pressure xenon lamp of 450 W at a distance of 300 mm, incident radiation being substantially normal to the surface of the ocular.

NOTE — It is permissible, for routine testing, to reduce the time of exposure and the distance to the ocular, for example, to 50 h at 200 mm.

5.1.2 *Eye-Protector Assembly* — Eye-protectors shall ensure a sufficiently wide field of vision to make it possible to do the work for which they are provided, without discomfort or risk.

NOTE — For eye-cup type protectors the minimum temporal and downward fields of vision shall be 50° and 60° respectively. For wide-vision protectors these values shall be at least 60° and 67° respectively.

5.1.2.1 *Stability at elevated temperature* — The assembled eye-protectors shall be stable at elevated temperature (55 ± 2°C), and, when tested in accordance with the method given in **3** of IS : 7524 (Part I)-1980*, shall show no apparent deformation. At the end of the test, the optical qualities shall not have deteriorated beyond the limits laid down in **5.1.1.2**.

5.1.2.2 *Resistance to corrosion* — All metal parts of an eye-protector shall display smooth surfaces free from oxidation when they are examined by the naked eye (or, if necessary, with spectacles) by a trained observer, after the eye-protector has undergone that test for resistance to corrosion in accordance with the method given in **6** of IS : 7524 (Part I)-1980*.

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*Methods of test for eye-protectors: Part I Non-optical tests (*first revision*).

5.1.2.3 *Suitability for disinfection* — All parts of eye-protectors shall be capable of withstanding disinfection without visible damage as adjudged in accordance with the method given in **7** of IS : 7524 (Part I)-1980*.

NOTE — Any other method, recommended by the manufacturer may be adopted if it has been shown to be equally effective.

5.1.2.4 At the end of the test, the eye-protectors shall meet the following mechanical and optical requirements:

a) The amount of diffused light should not exceed the permissible limit given in **5.1.1.3** by more than 25 percent.

b) The robustness of oculars made of synthetic material and laminated glass shall not have fallen below that specified in **5.1.1.6**.

c) The ultra-violet infra-red and visible transmittances shall remain within the limits to which the ocular belongs before the test (*see* **5.2.1.1**).

5.2 Specific Requirements

5.2.1 *Oculars*

5.2.1.1 *Transmittance* — Transmittance variations measured by scanning with a light beam of 5 mm diameter over the entire area of an ocular, except in the marginal area 5 mm wide, shall remain within the limits defined as 'relative uncertainty' in Table 2 of IS : 7524 (Part II)-1980†.

NOTE — In the case of curved oculars, the limits shall apply only to the optical viewing area.

a) *Oculars without filtering action* — If oculars are used solely to protect the eyes against mechanical and chemical hazards, their luminous transmittance shall be within the limits of shade number 1·2 (*see* Table 1).

b) *Oculars with filtering action* — If oculars are used to protect the eyes against harmful radiations, that is, as welding filters, ultra-violet filters, infra-red filters or daylight filters, they shall comply with transmittance requirements and appropriate chromaticity limits as prescribed in Appendix B.

5.2.2 *Eye-Protector Assembly*

5.2.2.1 *Flame resistance* — Oculars and frames shall not be made of flammable materials such as cellulose nitrate. Those made of cellulose acetate and cellulose acetate butyrate are considered acceptable.

a) Industrial eye-protectors shall be considered as satisfactory if they do not ignite or continue to glow after removal of the welding rod, when they are tested in accordance with the method prescribed in **8.1** of IS : 7524 (Part I)-1980*.

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*Methods of test for eye-protectors: Part I Non-optical tests (*first revision*).

†Methods of test for eye-protectors: Part II Optical tests (*first revision*).

b) Eye-protectors used by professionals solely for the attenuation of daylight shall be regarded as satisfactory if they do not ignite during the test period when tested in accordance with the method prescribed in **8.2** of IS : 7524 (Part I)-1980*.

NOTE — If the material composition of the eye-protector is changed, the eye-protector shall be retested.

5.2.2.2 *Protection against high velocity particles* — Eye-protectors intended to provide protection against impact from objects or particles flying at high velocity shall be designed and constructed to withstand the impact of a 6 mm diameter steel ball striking the ocular at a known selected speed up to 190^{+5}_{-0} m/s when tested in accordance with the method prescribed in **9** of IS : 7524 (Part I)-1980*.

NOTE 1 — For speeds greater than 100 m/s, use of face-shields is recommended.

NOTE 2 — Ballistic testing of the eye-protectors with other projectile sizes and speeds is permitted, provided that the dimensions of the steel ball and its speed are comparable to those found in the work place.

When tested as above, the eye-protector shall not display the following defects:

a) *Ocular fracture* — an ocular shall be considered to have fractured if it cracks through its entire thickness and on its entire diameter, if two or more pieces visible to the naked eye become detached from the surface remote from that struck by the ball, or if the ball passes through the ocular;

b) *Ocular deformation* — an ocular shall be considered as deformed if a mark appears on the white paper on the side opposite to that struck by the ball; and

c) *Ocular housing or frame failure* — an ocular housing or frame shall be considered to have failed if it separates into several parts or if it is no longer capable of holding an ocular in position.

5.2.2.3 *Protection against molten metal and hot solids* — The material of all parts providing protection for the eye-area shall be non-metallic or treated to prevent the adherance of molten metal and shall be resistant to the penetration of hot solids.

NOTE — This requirement does not relate to any particular type of eye-protector; the type should be chosen in relation to its use.

The materials shall be regarded as satisfactory if, when tested in accordance with the method prescribed in **10** of IS : 7524 (Part I)-1980*, there is no adherance of molten metal and also, when tested in accordance with **11** of IS : 7524 (Part I)-1980*, complete penetration of the ball does not occur within a period of 7s.

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*Methods of test for eye-protectors: Part I Non-optical tests (*first revision*).

5.2.2.4 *Protection against chemical splashes* — Eye-protectors intended for protection against chemical splashes shall be considered satisfactory if no coloration appears in the area enclosed by the eye-protector, when they are tested in accordance with the method prescribed in **12** of IS : 7524 (Part I)-1980*.

NOTE — 'Creeping' of red colour immediately at the edges shall be ignored provided the coloration does not develop for a distance greater than 6 mm within the area enclosed by the eye-protector.

5.2.2.5 *Protection against dust* — Eye-protectors intended for protection against dust shall be considered as satisfactory if the reflectance after the test is not less than 80 percent of its value before testing, when they are tested in accordance with the method prescribed in **13** of IS : 7524 (Part I)-1980*.

5.2.2.6 *Protection against gases and vapours* — Eye-protector intended for protection against gases and vapours shall be considered as satisfactory if no staining appears in the area enclosed by the eye-protector when it is tested in accordance with the method prescribed in **14** of IS : 7524 (Part I)-1980*.

NOTE 1 — No account shall be taken of any darkening in the immediate vicinity of the edges, provided that it does not develop further than 6 mm within the area enclosed by the eye-protector.

NOTE 2 — As eye-protectors intended for protection against chemicals, dust and gas are tested for resistance to penetration on a standard head-form, greatest care should be taken to ensure a proper fit of the individual piece.

6. TESTS

6.1 Oculars — Oculars of eye-protectors shall be subjected to appropriate tests listed in Table 4 and in the sequence described therein.

6.1.1 The tests shall be conducted on not less than 10 oculars of each type, or 5 pairs of each type of oculars, and each ocular shall satisfy the requirements of the relevant tests.

6.2 Eye-Protector Assembly — Eye-protectors shall be subjected to appropriate tests listed in Table 5, and in sequence described therein.

6.2.1 The tests shall be conducted on not less than 5 assembled eye-protectors of each design or model and each protector shall satisfy the requirements of the relevant tests.

7. MARKING AND PACKING

7.1 Marking — Oculars and eye-protector frames shall be marked as given in Table 6.

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*Methods of test for eye-protectors: Part I Non-optical tests (*first revision*).

TABLE 4 SCHEDULE OF TESTS FOR OCULARS

(*Clause* 6.1)

SL No.	TEST	OCULARS			REF TO CLAUSE
		General Purpose (with Mechanical Hazard)	High Velocity Impact	Filtering Actions	
(1)	(2)	(3)	(4)	(5)	(6)
i)	Optical	×	×	×	5.1.1.2
ii)	Robustness	×	—	×	5.1.1.6
iii)	Stability	×	×	×	5.1.1.7
iv)	Transmittance:				
	a) Non-filtering	×	×	×	5.2.1.1(a)
	b) Filtering	—	—	×	5.2.1.1(b)
v)	High velocity impact	—	×	—	5.2.2.2
vi)	Molten metal and hot solids	—	o	o	5.2.2.3

× = mandatory
o = optional

7.1.1 Eye-protectors made for protection against combination of hazards such as highly velocity impact and/or molten metal with splashes, dust or gas, shall be marked on the oculars as for high velocity impact and/or molten metal and on the frames as for high velocity impact and/or molten metal and letter 'S', 'D' or 'G' as appropriate (*see* Table 6).

NOTE — Glass oculars supplied for use in high velocity impact and/or molten metal eye-protectors in combination with plastics lenses shall be additionally marked with the word 'outer' on the plastics layer.

7.1.2 Replacement glass lenses for use in high velocity impact eye-protectors shall have affixed to them labels stating that they shall be backed by plastics lenses.

7.1.3 Eye-protectors shall also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

TABLE 5 SCHEDULE OF TESTS FOR EYE-PROTECTORS

(*Clause* 6.2)

Use of Eye-Protector	Optical 5.1.1.2	Robustness 5.1.1.6	Heat Stability 5.1.2.1	Corrosion 5.1.2.2	Disinfection 5.1.2.3	Transmittance		Flame Resistance 5.2.2.1	High Velocity Impact 5.2.2.2	Molten Metal and Hot Solids 5.2.2.3	Chemical Splashes 5.2.2.4	Dust 5.2.2.5	Gas and Vapours 5.2.2.6
						5.2.1.1 (*a*)	5.2.1.1 (*b*)						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
General purpose	×	×	×	×	×	×	—	×	—	—	—	—	—
High velocity impact	×	—	×	×	×	×	—	×	×	—	—	—	—
Molten metal and hot solids	×	o	×	×	×	×	×	×	—	×	—	—	—
Splashes	×	o	×	×	×	×	—	×	—	—	×	—	—
Dust	×	×	×	×	×	×	—	×	—	—	—	×	—
Gases and vapours	×	o	×	×	×	×	o	×	—	—	—	—	×
Filtering action	×	o	×	×	×	—	×	×	o	o	—	—	—
Combination as above	×	o	×	×	×	×	o	×	o	o	o	o	o

× = mandatory
o = optional

TABLE 6 MARKING OF EYE-PROTECTORS

(*Clause* 7.1)

SL No.	TYPE OF EYE-PROTECTOR	OCULAR MARKING	FRAME MARKING
(1)	(2)	(3)	(4)
i)	General purpose	The letter 'H' where the ocular is heat treated. The letter 'C' where the ocular is chemically toughened	i) Manufacturer's name or recognized trademark, if any
		Oculars of goggles which pass the high velocity impact test may be marked with letter 'V' but not the goggles themselves	ii) Number of the Indian Standard
ii)	High velocity impact	As for the general purpose and the letter 'V'	As for the general purpose and the letter 'V'
iii)	Molten metals and hot solids	As for the general purpose and the letter 'M'	As for the general purpose and the letter 'M'
iv)	Splashes	As for the general purpose	As for the general purpose and the letter 'S'
v)	Dust	As for the general purpose	As for the general purpose and the letter 'D'
vi)	Gases and vapours	As for the general purpose	As for the general purpose and the letter 'G'
vii)	Filtering action	As for the general purpose and the designation (to be visible when mounted)	As for the general purpose and the letter 'F'

7.2 Packing — Eye-protectors shall be packed as agreed to between the purchaser and the supplier.

8. SAMPLING

8.1 The method of drawing representative samples of eye-protectors (and oculars, when supplied separately) and the criteria for their conformity with this standard shall be as given in Appendix C.

APPENDIX A

[*Clauses* 2.29(b) *and* B-4.1.1, *Note* 2]

SPECIAL DISTRIBUTION OF SOLAR ENERGY IN INFRA-RED SPECTRUM

A-0. GENERAL

A-0.1 Values for spectral distribution of solar radiation energy in the infra-red spectrum have been provided in Table 7 for calculation of transmittance in the infra-red spectrum.

TABLE 7 SPECTRAL DISTRIBUTION OF SOLAR RADIATION ENERGY IN THE INFRA-RED SPECTRUM

(*Clause* A-0.1)

WAVE-LENGTH nm	SPECTRAL IRRADIANCE (POWER PER UNIT OF AREA AND PER WAVELENGTH) MW/m^3	WAVE-LENGTH nm	SPECTRAL IRRADIANCE (POWER PER UNIT OF AREA AND PER WAVELENGTH) MW/m^3	WAVE-LENGTH nm	SPECTRAL IRRADIANCE (POWER PER UNIT OF AREA AND PER WAVELENGTH) MW/m^3
		1 200	373	1 650	173
		1 210	402	1 660	163
		1 220	431	1 670	159
780	907	1 230	420	1 680	145
790	923	1 240	387	1 690	139
800	857	1 250	328	1 700	132
810	698	1 260	311	1 710	124
820	801	1 270	381	1 720	115
830	863	1 280	382	1 730	105
840	858	1 290	346	1 740	97·1
850	839	1 300	264	1 750	80·2
860	813	1 310	208	1 760	58·9
870	798	1 320	168	1 770	338·8
880	614	1 330	115	1 780	18·4
890	517	1 340	58·1	1 790	5·70
900	480	1 350	18·1	1 800	0·920
910	375	1 360	0·660	1 810	—
920	258	1 370	—	1 820	—
930	169	1 380	—	1 830	—
940	278	1 390	—	1 840	—
950	487	1 400	—	1 850	—
960	584	1 410	1·91	1 860	—
970	633	1 420	3·72	1 870	—
980	645	1 430	7·53	1 880	—
990	643	1 440	13·7	1 890	—
1 000	630	1 450	23·8	1 900	—
1 010	620	1 460	30·5	1 910	0·705
1 020	610	1 470	45·1	1 920	2·34
1 030	601	1 480	83·7	1 930	3·68
1 040	592	1 490	128	1 940	5·30
1 050	551	1 500	157	1 950	17·7
1 060	526	1 510	187	1 960	31·7
1 070	519	1 520	209	1 970	37·7
1 080	512	1 530	217	1 980	22·6
1 090	514	1 540	226	1 990	1·58
1 100	252	1 550	221	2 000	2·66
1 110	126	1 560	217		
1 120	69·9	1 570	213		
1 130	98·3	1 580	209		
1 140	164	1 590	205		
1 150	216	1 600	202		
1 160	271	1 610	198		
1 170	328	1 620	194		
1 180	346	1 630	189		
1 190	344	1 640	184		

APPENDIX B

(*Clause* 5.2.1.1)

TRANSMITTANCE AND CHROMATICITY LIMITS OF FILTERS AND GUIDANCE ON THEIR SELECTION AND USE

B-0. GENERAL

B-0.1 Transmittance requirements and limits of chromaticity have been prescribed for filters for protection against harmful radiations. Information useful in the selection and use of such filters has also been provided.

B-1. WELDING FILTERS

B-1.1 Transmittance — Transmittance requirements for filters used in welding shall be as given in Table 8.

B-1.1.1 In addition, the filters shall also comply with the requirements given below:

Range of Wavelength, nm	*Permissible Transmittance*
From 210 to 313	Not to exceed the value specified for 313 nm
From 313 to 365	Not to exceed the value specified for 365 nm
From 365 to 400	The mean spectral transmittance not to exceed the mean luminous transmittance T_V

NOTE 1 — Luminous transmittance values are based on the spectral distribution of illuminant A of the CIE.

NOTE 2 — Minimum and maximum values of luminous transmittance may be exceeded by taking into account the limits of relative uncertainty given in Table 2 of IS : 7524 (Part II)-1980*.

NOTE 3 — The infra-red transmittance values are determined by integration of spectral transmittance in the infra-red range.

B-1.1.2 *Special Filters for Flame-Welding with a Flux* — When a flux is used in flame-welding, the light emitted by the source is often very rich in monochromatic light of one or more wavelengths, which makes it very difficult to follow the work properly; for example, light from sodium and lithium which is rich in radiations of wavelengths 589 nm and 671 nm respectively.

B-1.1.2.1 It is recommended that filters or combination of filters, with a selective absorption for 589 nm and 671 nm lines be used in order to eliminate the inconvenience caused by the intense emission of monochromatic radiation.

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*Methods of test for eye-protectors: Part II Optical tests (*first revision*).

TABLE 8 TRANSMITTANCE REQUIREMENTS FOR FILTERS USED IN WELDING

[*Clauses* B-1.1 *and* B-1.3(b)]

Sl No.	Designation of Welding Filters	Transmittance in the Ultra-Violet (UV) Spectrum, T (λ)		Luminous Transmittance (TV)		Mean Transmittance in the Infra-Red (IR) Spectrum	
		At 313 nm percent, *Max*	At 365 nm percent, *Max*	Percent, *Max*	Percent, *Min*	Near (IR), T_{NIR} 1 300 to 780 nm percent, *Max*	Mid (IR), T_{MIR} 2 000 to 1 300 nm percent, *Max*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	1·2	0·000 3	50	100	74·4	37	37
ii)	1·4	0·000 3	35	74·4	58·1	33	33
iii)	1·7	0·000 3	22	58·1	43·2	26	26
iv)	2·0	0·000 3	14	43·2	29·1	21	13
v)	2·5	0·000 3	6·4	29·1	17·8	15	9·6
vi)	3	0·000 3	2·8	17·8	8·5	12	7·5
vii)	4	0·000 3	0·95	8·5	3·2	6·4	5·4
viii)	5	0·000 3	0·30	3·2	1·2	3·2	3·2
ix)	6	0·000 3	0·10	1·2	0·44	1·7	1·9
x)	7	0·000 3	0·037	0·44	0·16	0·81	1·2
xi)	8	0·000 3	0·013	0·16	0·061	0·43	0·68
xii)	9	0·000 3	0·004 5	0·061	0·023	0·20	0·39
xiii)	10	0·000 3	0·001 6	0·023	0·008 5	0·10	0·25
xiv)	11	Value less than or equal to transmittance factor for 365 nm	0·000 60	0·008 5	0·003 2	0·050	0·15
xv)	12		0·000 20	0·003 2	0·001 2	0·027	0·096
xvi)	13		0·000 076	0·001 2	0·000 44	0·014	0·060
xvii)	14		0·000 027	0·000 44	0·000 16	0·007	0·04
xviii)	15		0·000 009 4	0·000 16	0·000 061	0·003	0·02
xix)	16		0·000 003 4	0·000 061	0·000 023	0·003	0·02

B-1.1.2.2 Filters which fulfil these conditions are indicated by the suffix 'a'. The transmittance of these filters for the wavelengths 589 nm and 671 nm shall be:

0·4 percent for designation 4 a,
0·1 percent for designation 5 a,
0·05 percent for designation 6 a, and
0·01 percent for designation 7 a.

Besides, these filters shall have the same characteristics, as the filters which correspond to designation 4, 5, 6 and 7 (*see* Table 8).

B-1.2 Selection and Use of Filters

B-1.2.0 *General* — Many factors are involved in selecting the opacity of a protective filter, in the visible range, which is suitable for welding or related techniques, for example:

a) for flame-welding and related techniques such as braze-welding and thermal cutting, this standard refers to the flow rate of blow pipes. However, in light alloy welding account should be taken of the characteristics of the fluxes, which influence the spectral composition of the light emitted; and

b) for arc-welding, arc-gouging and plasma jet thermal cutting, the current is an essential factor in making and accurate choice possible. In addition, in arc-welding, the type of parent metal is also to be taken into consideration.

B-1.2.0.1 Other parameters have a significant influence, but it is difficult to evaluate their effect. These are, in particular:

a) the position of the operator in relation to the flame or the ore, for example, depending on whether the operator leans over his work or adopts an arm's length position, a variation in opacity of at least one shade may be necessary;
b) local lighting; and
c) the human factor.

B-1.2.0.2 For these various reasons, this standard only gives designation of filters which confirmed practical experience has shown to be valid in normal circumstances for the personal protection of operators with normal sight, carrying out work of a specified type manually.

B-1.2.0.3 The designations of the filter to be used can be read from Tables 9, 10, 11 and 12. These tables are valid for average working conditions, in which the distance from the welder's eye to the pool of molten metal is approximately 50 cm and the average lighting intensity is approximately 100 lx.

B-1.2.1 *Designations of Filters to be used for Flame-Welding and Braze-Welding* — The designations to be used for manual flame-welding are given in Table 9.

TABLE 9 DESIGNATIONS FOR FILTERS FOR FLAME-WELDING AND BRAZE-WELDING DESIGNATION

(*Clauses* B-1.2.0.3 *and* B-1.2.1)

FLOW-RATE OF ACETYLENE	DESIGNATION OF FILTERS FOR FLAME-WELDING AND BRAZE-WELDING OF HEAVY METALS	DESIGNATION OF FILTERS FOR WELDING WITH EMITIVE FLUXES
(1)	(2)	(3)
l/h		
Up to 70	4	4a
71 to 200	5	5a
201 to 800	6	6a
801 and above	7	7a

NOTE — Next higher or lower designation may be used according to the conditions of use.

B-1.2.2 *Designations of Filters to be used for Oxygen Cutting* — The designations to be used for manual oxygen cutting following a line on the workpiece are given in Table 10.

TABLE 10 DESIGNATIONS OF FILTERS FOR OXYGEN CUTTING

(*Clauses* B-1.2.0.3 *and* B-1.2.2)

FLOW-RATE OF OXYGEN	DESIGNATION OF FILTERS FOR OXYGEN CUTTING
(1)	(2)
l/h	
900 to 2 000	5
2 001 to 4 000	6
4 001 to 8 000	7

NOTE 1 — Filters having next higher or lower designation may be used according to the conditions of use.

NOTE 2 — The rates of flow of 900 to 2 000 and 2 001 to 8 000 litres per hour of oxygen correspond fairly closely to the use of cutting nozzle of 1 to 1·5 and 2 mm respectively.

B-1.2.3 *Designations of Filters to be used for Plasma Jet Thermal Cutting* — The designations to be used for manual plasma jet thermal cutting following a line on the workpiece are given in Table 11.

TABLE 11 DESIGNATIONS OF FILTERS FOR PLASMA JET THERMAL CUTTING

(*Clauses* B-1.2.0.3 *and* B-1.2.3)

CURRENT	DESIGNATIONS OF FILTERS FOR THERMAL CUTTING
(1)	(2)
A	
Up to 150	11
151 to 250	12
251 to 400	13

NOTE — Filters having next higher or lower designation may be used according to the conditions of use.

B-1.2.4 *Designations of Filter to be used for Electric Arc-Welding or Arc-Gouging* — The designations to be used for manual electric arc-welding or arc-gouging are given in Tables 12 and 13.

B-1.3 Remarks — From the point of view of eye protection and hygiene during welding operations and use of related techniques, the following points should be taken into account:

a) The designations of filters given in this standard are applicable to a normal work programme and are derived from experience gained in the practical application of welding processes and related techniques;

b) The use of a filter with a greater degree of opacity would not provide greater effective protection since the opacity of filters in the range of ultra-violet and infra-red radiation specified in Table 8 has been determined so that this should be the case;

c) If the use of a filter selected from the tables produces a feeling of discomfort, the lighting conditions and eye-sight of the operator should be tested;

d) It would be harmful to use a filter which is too opaque in as much as this would force the operator to stand too close to the source of radiation and this would be a disadvantage from the point of view of respiratory hygiene; and

e) For work carried out in the open air in strong natural light it is usually possible to reduce the opacity of the protective filter by one designation because of the reduction in contrast.

TABLE 12 DESIGNATIONS OF FILTERS FOR ELECTRIC ARC-WELDING OR ARC-GOUGING

(*Clauses* B-1.2.0.3 *and* B-1.2.4)

USE	Current in Amperes and Designations																			
	10	15	20	30	40	60	80	100	125	150	175	200	225	250	275	300	350	400	450	500
Covered elec-trodes (shielded metal arc)				9		10			11				12					13		14
MIG on heavy metals*							10		11				12					13		14
MIG on light alloys							10		11			12			13			14		15
TIG on all metals and alloys	9			10		11			12			13			14					
MAG						10		11	12				13				14			15
'Arc-air' gouging									10			11	12			13		14		15

*The expression 'heavy metals' applies to steels, alloy steels, copper and its alloys, etc.

NOTE 1 — Next higher or lower designation may be used, according to the conditions of use.

NOTE 2 — The symbol:

MIG — corresponds to the use of an arc operated by an inert gas: with an axial spray metal transfer;
TIG — corresponds to the use of a tungsten electrode arc protected by an inert gas;
MAG — corresponds to the use of an arc protected by carbon dioxide either pure or in mixture, and electrode arc protected by an inert gas; and
Arc-air — corresponds to the use of a carbon electrode and a compressed air jet used in gouging in order to remove the molten metal.

TABLE 13 DESIGNATIONS FOR FILTERS FOR DIRECT ARC-WELDING

(*Clause* B-1.2.4)

Current	Designations of Filters for Direct Arc-Welding
(1)	(2)
A	
Up to 1	5
1 to 2·5	6
2·5 to 5	7
5 to 9	8
9 to 15	9
15 to 36	10

Note — Filters having next higher or lower designation may be used according to the conditions of use.

B-2. ULTRA-VIOLET FILTERS

B-2.1 Transmittance — Transmittance requirements for filters used for protection against ultra-violet radiation shall be as given in Table 14.

TABLE 14 TRANSMITTANCE REQUIREMENTS FOR FILTERS FOR PROTECTION AGAINST ULTRA-VIOLET RADIATION

Designation of Filters	Transmittance in the Ultra-Violet (*UV*) Spectrum T (λ)		Luminous Transmittance, (T_V)		Transmittance in the Infra-Red Spectrum (*IR*)
	At 313 nm percent, *Max*	At 365 nm percent, *Max*	Percent, *Max*	Percent, *Min*	
(1)	(2)	(3)	(4)	(5)	(6)
2-1·2	0·000 3	0·3	100	74·4	Not prescribed
2-1·4	0·000 3	0·3	74·4	58·1	
3-1·2	0·000 3	50	100	74·4	
3-1·4	0·000 3	35	74·4	58·1	
3-1·7	0·000 3	22	58·1	43·2	
3-2	0·000 3	14	43·1	29·1	
3-2·5	0·000 3	6·4	29·1	17·8	
3-3	0·000 3	2·8	17·8	8·5	
3-4	0·000 3	0·95	8·5	3·2	
3-5	0·000 3	0·30	3·2	1·2	

B-2.1.1 In addition the filters shall also comply with the requirements given below:

Range of Wavelength, nm	*Permissible Transmittance*
From 210 to 313	Not to exceed the value specified for 313 nm
From 313 to 365	Not to exceed the value specified for 365 nm
From 365 to 380	Not to exceed the luminous transmittance (*see* Table 14)

In the wavelength range between 405 and 610 nm, the spectral transmittance for the filters having designations 3-1·2 to 3-5 shall not deviate from the luminous transmittance by more than 70 percent of that value.

NOTE — Luminous transmittance values are based on the spectral distribution of illuminant A of the CIE.

B-2.2 Selection and Use of Filters — For protection against ultra-violet radiation, filters shall be selected from those classified by code numbers 2 or 3 as given in Table 15. Code number 2 filters may have a yellowish tinge which may modify colour perception. When it is important to have correct colour perception, it is preferable to choose code number 3 filters. Choice of a suitable filter also depends upon the degree of glare.

B-3. INFRA-RED FILTERS

B-3.1 Transmittance — Transmittance requirements for filters used for protection against infra-red radiation shall be as given in Table 16.

B-3.1.1 In addition the filters shall also comply with the requirements given below:

a) maximum transmittance in the ultra-violet spectrum for all designation:

$$T\,(\lambda) = 313\ \text{nm} > 0{\cdot}1\ T_V$$

b) between 210 and 313 nm, transmittance shall not exceed that specified for 313 nm

NOTE — Luminous transmittance values as shown in Table 16 and chromaticity coordinates for infra-red filters (*see* Fig. 2) shall be based on the spectral distribution for a full radiator 1 900 K and the CIE (1931) standard observer (2°) (*see* Table 17).

B-3.2 Chromaticity Limits — The tint representative point of an infra-red filter may be within the area defined in Fig. 2.

TABLE 15 SELECTION OF FILTERS FOR PROTECTION AGAINST ULTRA-VIOLET RADIATION

(*Clause* B-2.2)

Designation of Filters	Properties	Typical Applications
(1)	(2)	(3)
2-1·2	Filters may change colour perception. Appearance: very pale yellow	For use when total absorption of ultra-violet radiation is required
2-1·4	Filters may change colour perception. Appearance: pale yellow	For use when some absorption of visible light is required in addition to total absorption of ultra-violet radiation
3-1·2 3-1·4 3-1·7	No substantial modification of colour perception	For use with sources which produce predominantly ultra-violet radiation when glare is not an important factor. The lightest shades are effective in photographic reproduction work
3-2·0 3-2·5	No substantial modification of colour perception	For use with sources which produce both ultra-violet radiation and visible light to a high degree (for example, in ultra-violet ray therapy particularly medical treatment)
3-3 3-4	No substantial modification of colour perception	For use with high pressure mercury vapour lamps and ultra-violet source (for example, ultra-violet ray treatment, especially when carried out by the patients themselves)
3-5	No substantial modification of colour perception	For use with ultra-violet sources which also emit a high proportion of visible light (for example, very high pressure mercury vapour lamps used in laboratories and medical treatment)

TABLE 16 TRANSMITTANCE REQUIREMENTS FOR FILTERS FOR PROTECTION AGAINST INFRA-RED RADIATION

(Clause B-3.1)

DESIGNATION OF FILTERS	LUMINOUS TRANSMITTANCE (T_V)		TRANSMITTANCE IN THE INFRA-RED (*IR*) SPECTRUM	
	Percent, *Max*	Percent, *Min*	Near Infra-Red (T_{NIR}) 1 300 to 780 nm Percent, *Max*	Mid Infra-Red (T_{MIR}) 2 000 to 1 300 nm Percent, *Max*
(1)	(2)	(3)	(4)	(5)
4-1·2	100	74·4	37	37
4-1·4	74·4	58·1	33	33
4-1·7	58·1	43·2	26	26
4-2	43·2	29·1	21	13
4-2*a*	43·2	29·1	0·20	0·20
4-2·5	29·1	17·9	15	9·6
4-2·5*a*	29·1	17·9	0·20	20·20
4-3	17·9	8·5	12	8·5
4-4	8·5	3·2	6·4	5·4
4-5	3·2	1·2	3·2	3·2
4-6	1·2	0·44	1·7	1·9
4-7	0·44	0·16	0·81	1·2
4-8	0·16	0·061	0·43	0·68
4-9	0·061	0·023	0·20	0·39
4-10	0·023	0·008 5	0·10	0·25

B-3.2.1 The following limits are recommended:

a) *Purple limit*
$(x-0{\cdot}52)^2+(y-0{\cdot}13)^2=0{\cdot}263^2$
arc of a circle with radius of 0·263, the centre coordinates of which are $x=0{\cdot}52$, $y=0{\cdot}13$

b) *Red limit*
$y=1{\cdot}333\,x-0{\cdot}34$

c) *Yellow limit*
$y=0{\cdot}790-0{\cdot}667\,x$

d) *Yellow green limit*
$y=0{\cdot}440$

e) *Green limit*
$y=0{\cdot}836\,x+0{\cdot}090$

f) *Blue limit*
$x=0{\cdot}310$

B-3.3 Selection and Use of Filters — For protection against infra-red radiation filters may be selected from those classified by code number 4 as given in Table 18.

TABLE 17 FACTORS FOR THE CALCULATION OF SPECTRAL TRANSMITTANCE AND CHROMATICITY COORDINATES OF FILTERS RELATIVE TO A FULL RADIATOR 1 900 K AND THE CIE (1931) STANDARD OBSERVER (2°)

(*Clause* B-3.1.1)

λnm (1)	$S(\lambda)$ (2)	$S(\lambda)\bar{x}(\lambda)$ (3)	$S(\lambda)\bar{y}(\lambda)$ (4)	$S(\lambda)\bar{z}(\lambda)$ (5)
380	1·15	0·000	0·000	0·001
390	1·68	0·001	0·000	0·003
400	2·41	0·003	0·000	0·013
410	3·38	0·012	0·000	0·057
420	4·65	0·051	0·002	0·246
430	6·28	0·146	0·006	0·713
440	8·36	0·238	0·016	1·196
450	10·95	0·302	0·034	1·589
460	14·14	0·337	0·070	1·934
470	18·03	0·289	0·134	1·901
480	22·70	0·178	0·258	1·512
490	28·25	0·074	0·481	1·077
500	34·78	0·014	0·920	0·775
510	42·40	0·032	1·747	0·550
520	51·19	0·265	2·978	0·328
530	61·26	0·831	4·326	0·212
540	72·69	1·729	5·681	0·121
550	85·58	3·039	6·976	0·061
560	100·00	4·871	8·152	0·032
570	116·04	7·245	9·050	0·020
580	133·75	10·041	9·534	0·019
590	153·21	12·882	9·502	0·014
600	174·46	15·182	9·019	0·011
610	197·54	16·226	8·141	0·005
620	222·49	15·574	6·945	0·004
630	249·32	13·122	5·413	0·000
640	278·06	10·203	3·987	0·000
650	308·69	7·170	2·706	0·000
660	341·22	4·610	1·705	0·000
670	375·62	2·690	0·985	0·000
680	422·73	1·579	0·574	0·000
690	444·94	0·837	0·302	0·000
700	489·78	0·457	0·165	0·000
710	531·34	0·252	0·091	0·000
720	574·57	0·137	0·047	0·000
730	619·39	0·071	0·025	0·000
740	665·73	0·038	0·016	0·000
750	713·53	0·018	0·006	0·000
760	762·69	0·013	0·006	0·000
770	813·14	0·007	0·000	0·000
780	864·78	0·000	0·000	0·000

Constant $C_2 = 1{\cdot}438\ 79 = 10^{-2}$ m.k

$$\sum_{380}^{780} S(\lambda)\ y(\lambda) = 100{\cdot}00$$

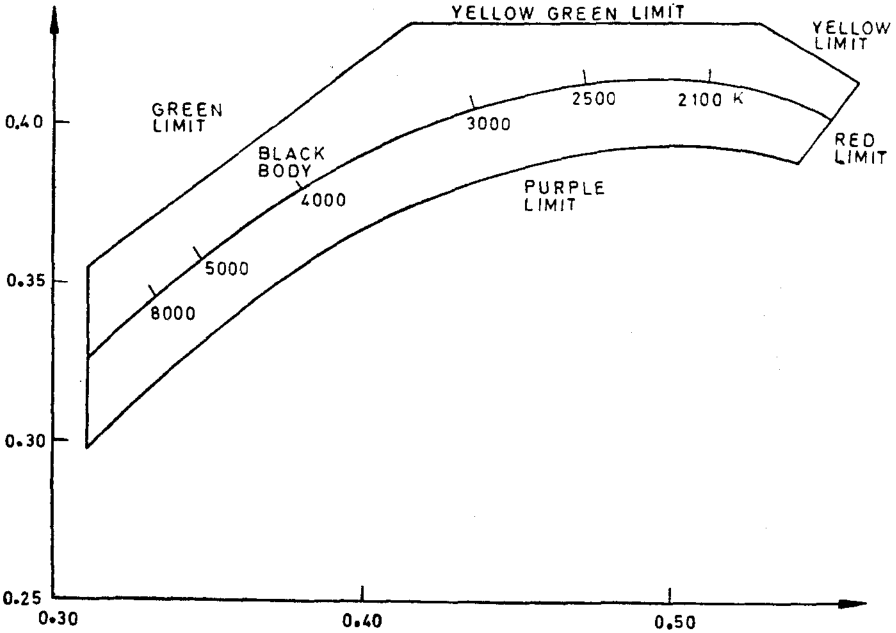

FIG. 2 CHROMATICITY LIMITS FOR INFRA-RED FILTERS

TABLE 18 SELECTION OF FILTERS FOR PROTECTION AGAINST INFRA-RED RADIATION

(*Clause* B-3.3)

DESIGNATION OF FILTERS (1)	TYPICAL APPLICATION IN TERMS OF MEAN TEMPERATURE SOURCES, °C (2)
4-1·2	1 050
4-1·4	1 070
4-1·7	1 090
4-2	1 110
4-2·5	1 140
4-3	1 210
4-4	1 290
4-5	1 390
4-6	1 500
4-7	1 650
4-8	1 800
4-9	2 000
4-10	2 150
4-2*a* 4-2·5*a*	(For protection against infra-red radiation from sources of large area where protection against glare is not essential, for example, in rolling mills.)

B-4. DAYLIGHT FILTERS

B-4.1 Transmittance — Transmittance requirements for filters used in daylight shall be as given in Table 19.

TABLE 19 TRANSMITTANCE REQUIREMENTS FOR FILTERS FOR USE IN DAYLIGHT

Designations of Filters	Transmittance in the Ultra-Violet (*UV*) Spectrum $T(\lambda)$		Luminous Transmittance (T_V)		Transmittance in the Infra-Red Spectrum T_{SIR}
	At 313 nm *Max*	At 350 nm *Max*	Percent, *Max*	Percent, *Min*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)
5-1·2	0·5T_V		100	74·4	Not prescribed
5-1·4			74·4	58·1	
5-1·7			58·1	43·2	
5-2·0			43·2	29·1	
5-2·5			29·1	17·8	
5-3			17·8	8·5	
5-4			8·5	3·2	
6-1·2	0·01T_V		100	74·4	T_V
6-1·4			74·4	58·1	
6-1·7			58·1	43·2	
6-2·0			43·2	29·1	
6-2·5			29·1	17·8	
6-3	0·001T_V		17·8	8·5	
6-4			8·5	3·2	

B-4.1.1 In addition, the filters shall also comply with the requirements given below:

Range of Wavelength, nm	*Permissible Transmittance*
From 210 to 313	Not to exceed the value specified for 313 nm
From 313 to 350	Not to exceed the value specified for 350 nm
From 450 to 650	Not less than the value 0·2 T_V

NOTE 1 — Luminous transmittance values as shown in Table 19 and chromaticity coordinates for daylight filters (*see* Fig. 3) shall be based on the spectral distribution of the CIE source C.

NOTE 2 — Transmittance in the infra-red spectrum (T_{SIR}) shall be calculated by using the spectral values given in Table 7 in Appendix A. An approximate measurement in the infra-red spectrum may also be made by using CIE source A and a neutral dector combined with the following filters:

Filter A — A cell containing distilled water the optical range for which is equivalent to 3 nm of water;

Filter B — A filter corresponding to the spectral transmittance given in col 2 of Table 20; and

Filter C — A filter corresponding to the spectral transmittance given in col 3 of Table 20.

TABLE 20 SPECTRAL TRANSMITTANCE OF SOLID FILTERS B AND C FOR MEASURING TRANSMITTANCE IN THE INFRA-RED SPECTRUM

(*Clause* B-4.1.1, *Note* 2)

WAVELENGTH	SPECTRAL TRANSMITTANCE	
	Filter B	Filter C
(1)	(2)	(3)
nm	Percent	Percent
700	0	—
720	0	—
740	< 1	—
760	<10	—
780	<40	—
800	>60	53±2
900	>85	44±2
1 000	>85	39±2
1 100	>85	38±2
1 200	>85	39±2
1 300	>85	40±2
1 400	>85	45±2
1 500	>85	50±2
1 600	>85	56±2
1 700	>85	60±2
1 800	>85	61±2
1 900	>85	61±2
2 000	>85	61±2

NOTE — Filter B is designed to eliminate only those radiations whose wavelength is less than 800 nm in so far as it is practicable by the technique of filters.

B-4.2 Chromaticity Limits — The tint representation point of a daylight filter may be within the area defined in Fig. 3.

B-4.2.1 The following limits (*see* Table 21) are recommended.

B-4.3 Selection and Use of Daylight Filters — Filters for use in daylight are usually chosen in accordance with the degree of ambient illumination. The amount of comfort provided by them also depends on latitude, altitude and other environmental factors. Sensitivity to glare also varies with the individual. Code 5 filters give some protection against ultra-violet radiation. Code 6 filters provides greater protection and, in addition, provide protection against infra-red radiation.

B-4.3.1 Filters for use in daylight may be selected from Table 22.

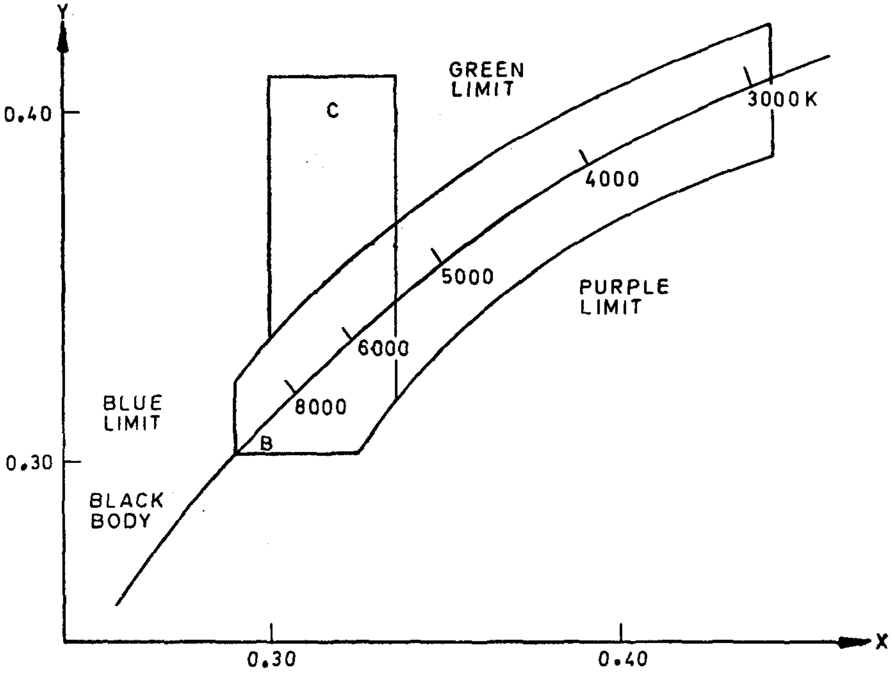

FIG. 3 CHROMATICITY LIMITS FOR DAYLIGHT FILTERS

TABLE 21 CHROMATICITY LIMITS FOR FILTERS USED IN DAYLIGHT

(*Clause* B-4.2.1)

LIMITS (1)	TOTAL LIMIT AT CHROMATICITY (2)	CHROMATICITY LIMIT FOR GRAY-BROWN FILTERS (A) (3)	CHROMATICITY LIMIT FOR GRAY-FILTERS (B) (4)	CHROMATICITY LIMIT FOR GRAY-GREEN FILTERS (C) (5)
Purple limit	Arc with radius r_1=0·319; centre coordinate x=0·557 y=0·088; Horizontal y=0·300	Arc with radius r_1=0·319; centre coordinates x=0·557 y=0·088	Arc with radius r_1=0·319; centre coordinates x=0·557 y=0·088; Horizontal y=0·300	Arc with radius r_1=0·354; centre coordinates x=0·557 y=0·088
Yellow limit	x=0·440	x=0·440	x=0·335	x=0·335
Green limit	Arc with radius r_2=0·354; centre coordinates x=0·557 y=0·088; Vertical x=0·335; Horizontal y=0·405	Arc with radius r_2=0·354; centre coordinates x=0·557 y=0·088	Arc with radius r_2=0·354; centre coordinates x=0·557 y=0·088	y=0·405
Blue limit	Arc with radius r_2=0·354; centre coordinates x=0·557 y=0·008; Vertical x=0·290; Horizontal y=0·300	x=0·335	x=0·290	x=0·300

TABLE 22 SELECTION OF FILTERS FOR DAYLIGHT

(*Clause* B-4.3.1)

DESIGNATIONS OF FILTERS	TYPICAL APPLICATIONS FOR
(1)	(2)
5-1·2 6-1·2	Continuous use by persons very sensitive to glare
5-1·4	Protection against glare, normally in the absence of sunlight
5-1·7 6-1·7	Protection against glare, usually in the absence of sunlight
5-2·0 6-2·0 5-2·5 6-2·5	General purpose filters for protection against sunlight
5-3 6-3	Protection against intense sunglare, usually in tropical and sub-tropical regions, but wherever there are vast flat surfaces of high reflectance as with some roads, snow and water, they can be used in sand, chalk and gravel quarries and other industrial sites, as well as for day-time observation of the sky
5-4 6-4	Use in very bright illumination

APPENDIX C

(*Clause* 8.1)

SAMPLING OF EYE-PROTECTORS

C-1. SCALE OF SAMPLING

C-1.1 Lot — In a single consignment, all the eye-protectors meant for the same purpose, with the same type of oculars, and designation of filters and made of the same material shall be grouped together to constitute a lot.

C-1.2 For ascertaining the conformity of the material in a lot to the requirements of the specification, each lot shall be tested separately.

C-1.3 The number of eye-protectors to be sampled and tested from the lot shall depend on the size of the lot and shall be in accordance with Table 23.

TABLE 23 SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVES

(*Clause* C-1.3)

NUMBER OF EYE-PROTECTORS IN THE LOT	VISUAL, DIMENSIONAL AND OPTICAL REQUIREMENTS		NO. OF TESTS FOR EACH OF THE CHARACTERISTICS REQUIRING DESTRUCTIVE TESTING
	Sample Size	Acceptance Number	
(1)	(2)	(3)	(4)
Up to 50	13	1	1
51 ,, 150	20	1	2
151 ,, 300	32	2	3
301 and above	50	3	4

C-1.3.1 The oculars if supplied separately shall be selected at random. In order to ensure the randomness of selection, guidance may be had from IS : 4905-1968*.

C-1.3.2 If the lot consists of cartons containing a number of eye-protectors, at least 50 percent of the cartons shall be opened and the required number of eye-protectors shall be collected by taking equal number from each carton.

C-2. NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

C-2.1 All the eye-protectors selected according to col 2 of Table 23 shall be examined for visual, dimensional and optical requirements of the specification. Any eye-protector failing to satisfy one or more of these requirements shall be termed as defective. The lot shall be deemed, to have satisfied these requirements if the number of defectives found in the sample is less than or equal to the corresponding acceptance number given in col 3 of Table 23.

C-2.2 The lot having been found satisfactory in visual, dimensional and optical requirements shall be further tested for the characteristics requiring destructive testing. The number of tests to be carried out for each of these characteristics shall be as given in col 4 of Table 23. For this purpose, required number of eye-protectors shall be randomly selected from those already examined and found satisfactory according to **C-2.1**. The lot shall be considered to have met the requirements for these characteristics if no failure occurs.

C-2.3 The lot shall be declared as conforming to the requirements of the specification if **C-2.1** and **C-2.2** are satisfied.

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*Methods for random sampling.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 $kg.m/s^2$
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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